Chapter 7 - Infiltration and Bio-infiltration Treatment Facilities

7.1 Purpose

This Chapter provides site suitability, design, and maintenance criteria for infiltration treatment systems. Infiltration treatment Best Management Practices (BMPs) serve the dual purpose of removing pollutants (TSS, heavy metals, phosphates, and organics) from stormwater and recharging aquifers.

A stormwater infiltration treatment facility is an impoundment, typically a basin, trench, or bio-infiltration swale whose underlying soil removes pollutants from stormwater. The infiltration BMPs described in this chapter include:

BMP T7.10 Infiltration basins
BMP T7.20 Infiltration trenches
BMP T7.30 Bio-infiltration swales

Infiltration treatment soils must contain sufficient organic matter and/or clays to sorb, decompose, and/or filter stormwater pollutants. Pollutant/soil contact time, soil sorptive capacity, and soil aerobic conditions are important design considerations.

The earlier sections of this Chapter provide information regarding site criteria, infiltration rates, site suitability, and guidance of a general nature for all of these BMPs. Later in the Chapter, detailed additional design criteria and considerations are provided for each specific BMP.

7.2 Application

These infiltration and bio-infiltration treatment measures are capable of achieving the performance objectives cited in Chapter 3 for specific treatment menus. In general, these treatment techniques can capture and remove or reduce the target pollutants to levels that:

- Will not adversely affect public health or beneficial uses of surface and ground water resources, and
- Will not cause a violation of ground water quality standards

Infiltration treatment systems are typically installed:

- As off-line systems, or on-line for small drainages
- As a polishing treatment for street/highway runoff after pretreatment for TSS and oil
- As part of a treatment train
- As retrofits at sites with limited land areas, such as residential lots, commercial areas, parking lots, and open space areas.
- With appropriate pretreatment for oil and silt control to prevent clogging. Appropriate pretreatment devices include a pre-settling basin, wet pond/vault, biofilter, constructed wetland, media filter, and oil/water separator.

An infiltration basin is preferred, where applicable, and where a trench or bio-infiltration swale cannot be sufficiently maintained.

7.3 General Considerations

Ecology proposes to delete sections 7.3.1 through 7.3.3 from this chapter. Most of these sections are a repeat of Chapter 3, Section 3.3 of Volume III. There were a few differences in this section intended to highlight certain design aspects that are necessary if infiltration through the soil profile is considered part of the treatment system. The proposed changes in Section 3.3 of Volume III incorporate those treatment considerations into the infiltration guidance for flow control purposes. The text of Section 3.3. in Volume III notes where certain design criteria or restrictions are applicable only to treatment designs not flow control designs. This places all detailed design guidance concerning infiltration in one location within the manual.

Please reference Section 3.3 of Volume III.

~~Discussed below are several considerations common to infiltration and bio-infiltration treatment.~~

~~7.3.1 Site Characterization Criteria~~

~~One of the first steps in siting and designing infiltration treatment facilities is to conduct a characterization study. Information gathered during initial geotechnical investigations can be used for the site characterization. Some of the key data and issues to be characterized includes the following:~~

~~Surface Features Characterization:~~

SSC-9 Verification Testing of the Completed Facility

Verification testing of the completed full-scale infiltration facility is recommended to confirm that the design infiltration parameters are adequate to manage the design volume and meet the pollutant capture objectives of the infiltrating soil. The site professional should determine the duration and frequency of the verification testing program for the potentially impacted ground water. The ground water monitoring wells installed during site characterization may be used for this purpose. Long-term in-situ drawdown and water quality monitoring for a two-year period, would be preferable.

7.3.4 General Information for Infiltration Basins, Trenches, and Bio-infiltration Swales

This section covers general design, construction, and maintenance criteria that apply to infiltration basins, trenches, and bio-infiltration swales.

Sizing Criteria

Size should be determined to meet ~~by one of~~ the following requirements~~methods~~:

1) Routing the runoff through the facility and infiltrate 91% of the runoff volume, as predicted by Western Washington Hydrology Model (WWHM) (or an approved, equivalent continuous runoff model) ~~through the facility~~; and~~or~~

2) ~~Using the Simple Method, discussed below, that i~~Infiltrates the Water Quality ~~Design Storm~~ Volume as calculated by WWHM (or an approved, equivalent continuous runoff model) within 48 ~~24~~ hours to meet the drawdown time requirements.

*(**ASKING FOR PUBLIC COMMENT ON REQUIRING THE DRAWDOWN TIME**: The purpose for requiring a drawdown time is to allow oxygenation of the soil beneath the facility to help prevent possible problems associated with septic conditions in the ground. Since the pond receives stormwater runoff which would probably have a relatively low biological oxygen demands, how valid is the septicity concern ? What is a reasonable drawdown time?).*

Treatment facilities placed upstream versus downstream of a detention facility AND put Off-line versus On-line ~~Treatment~~

Infiltration facilities for treatment can be located upstream or downstream of detention and can be off-line or on-line. For off-line facilities, the flow splitter should be designed to route the water quality design flow rate to the infiltration facility.

On-line treatment facilities placed ***upstream or downstream*** of a detention facility must be sized using a continuous runoff model (WWHM or an approved equivalent model) to infiltrate 91% of the runoff volume.

Off-line treatment facilities placed ***upstream*** of a detention facility must have a flow splitter designed to send all flows at or below the 15-minute water quality flow rate, as predicted by WWHM, to the treatment facility. The treatment facility must be sized to infiltrate all the runoff sent to it (no overflows from the treatment facility are allowed).

Off-line treatment facilities placed ***downstream*** of a detention facility must have a flow splitter designed to send all flows at or below the 2-year flow frequency from the detention pond, as predicted by WWHM, to the treatment facility. The treatment facility must be sized to infiltrate all the runoff sent to it (no overflows from the treatment facility are allowed).

See Chapter 4 for flow splitter design details.

~~Until a continuous runoff model is available that identifies the flow rate associated with 91% of the runoff volume, use:~~

- ~~estimate for that flow rate as identified in Chapter 4 for upstream facilities;~~
- ~~2-year return frequency flow rate for flows downstream of detention.~~

~~The storage pond above the infiltration surface should not overflow since all flows routed to it are at or below the water quality design flow rate.~~

Note: An emergency overflow should still be included in ~~the~~ all design formats – off-line and on-line. ~~. See Chapter 4 for flow splitter design details.~~

~~For on-line infiltration facilities, the storage pond should be sized to restrict the total amount of overflow to 9% of the total runoff volume of the long-term time series or less depending on the design objective.~~

Note: Refer to Volume III for overflow structure design details

~~Method of Design and Sizing Criteria Procedure~~

- **~~Simple Method~~**

  ~~$A_{inf} = A_t Q_d / Ft$~~

  ~~A_{inf} = Bottom surface area of infiltration facility~~
  ~~A_t = tributary drainage area~~
  ~~Q_d = the runoff depth for the 6-month, 24-hour storm, estimated using the SCS (NRCS) Curve Number Equations approach detailed in Volume III, Chapter 2.~~
  ~~F = long-term infiltration rate~~
  ~~t = 24 hours maximum drawdown time~~

- **~~Continuous Runoff Method~~**

  ~~Refer to Chapter 8 for sizing sand filters using the Continuous Runoff Model Sizing Method. The only difference for sizing an infiltration~~

~~facility is that the infiltration rate is a function only of surface area and ponded hydraulic head does not play a role. The long-term infiltration rate, as determined in Section 7.3.2 is multiplied by the horizontal surface area of an infiltration bed to obtain a volumetric infiltration rate that is input to the WWHM as a stage-storage-discharge table.~~

~~*Note: Horizontal surface area changes with stage if the sidewalls are sloped.*~~

- **Control of Side-Wall Seepage**

  Typically, side-wall seepage is not a concern if seepage occurs through the same stratum as the bottom of the facility. However, for engineered soils or for soils with very low permeability, the potential to bypass the treatment soil through the side-walls may be significant. In those cases, the side-walls must be lined, either with an impervious liner or with at least 18 inches of treatment soil, to prevent seepage of untreated flows through the side walls.

- **Construction Criteria**

  – Excavation - Initial excavation should be conducted to within 1-foot of the final elevation of the floor of the infiltration facility. Final excavation to the finished grade should be deferred until all disturbed areas in the upgradient watershed have been stabilized or protected. The final phase of excavation should remove all accumulated sediment. After construction is completed, prevent sediment from entering the infiltration facility by first conveying the runoff water through an appropriate pretreatment system such as a pre-settling basin, wet pond, or sand filter.

  – Infiltration facilities should generally not be used as temporary sediment traps during construction. If an infiltration facility is to be used as a sediment trap, it must not be excavated to final grade until after the upgradient drainage area has been stabilized. Any accumulation of silt in the basin must be removed before putting it in service.

  – Traffic Control - Relatively light-tracked equipment is recommended for excavation to avoid compaction of the floor of the infiltration facility. The use of draglines and trackhoes should be considered. The infiltration area should be flagged or marked to keep equipment away.

- **Maintenance Criteria**

  Provision should be made for regular and perpetual maintenance of the infiltration basin/trench, including replacement and/or reconstruction of the treatment infiltration medium. Maintenance should be conducted when water remains in the basin or trench for more than 24 hours or overflows the basin/pond. Adequate access for O&M must be

included in the design of infiltration basins and trenches. An Operation and Maintenance Plan, approved by the local jurisdiction, should ensure maintaining the desired efficiency of the infiltration facility.

Debris/sediment accumulation- Removal of accumulated debris/sediment in the basin/trench should be conducted every 6 months or as needed to prevent clogging, or when water remains in the pond for greater than 24hours.

The treatment soil should be replaced or amended as needed to ensure maintaining adequate treatment capacity.

- **Verification of Performance**

  During the first 1-2 years of operation verification testing as specified in SSC-9, is strongly recommended, along with a maintenance program that achieves expected performance levels. Operating and maintaining ground water monitoring wells is also strongly encouraged.

7.4 Best Management Practices (BMPs) for Infiltration and Bio-infiltration Treatment

This section will also be deleted as a very similar section already is included in Volume III, at the end of Chapter 3. Slight discrepancies in text between the two sections will be resolved.

The three BMPs discussed below are recognized currently as effective treatment techniques using infiltration and bio-infiltration. Selection of a specific BMP should be coordinated with the Treatment Facility Menus provided in Chapter 3.